Reaction-assisted diffusion bonding of Ti-6Al-4V to Al_2O_3

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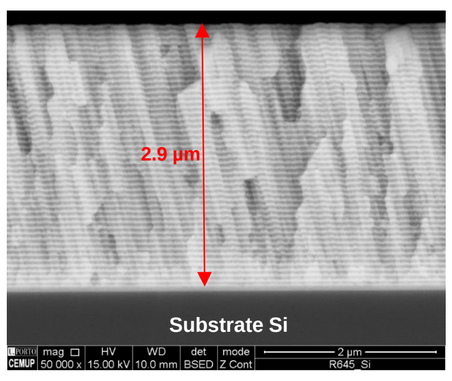
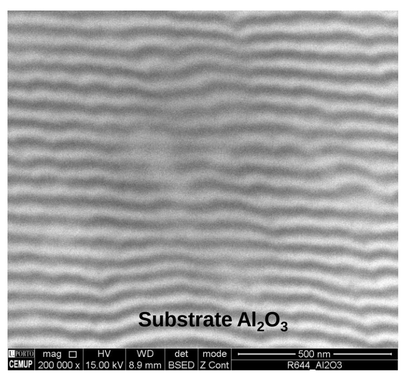
Objective

Diffusion bonding is one of the most suitable processes for producing joints with microstructural and mechanical soundness. This work aims at investigating joining of Ti-6Al-4V to Al_2O_3 using Ni/Ti reactive multilayer thin films (alternated Ni and Ti nanolayers) deposited by magnetron sputtering onto the base materials. Due to their exothermic and nanometric character, these multilayers might improve the diffusion bonding process between these dissimilar materials.

Depositions by Magnetron Sputtering

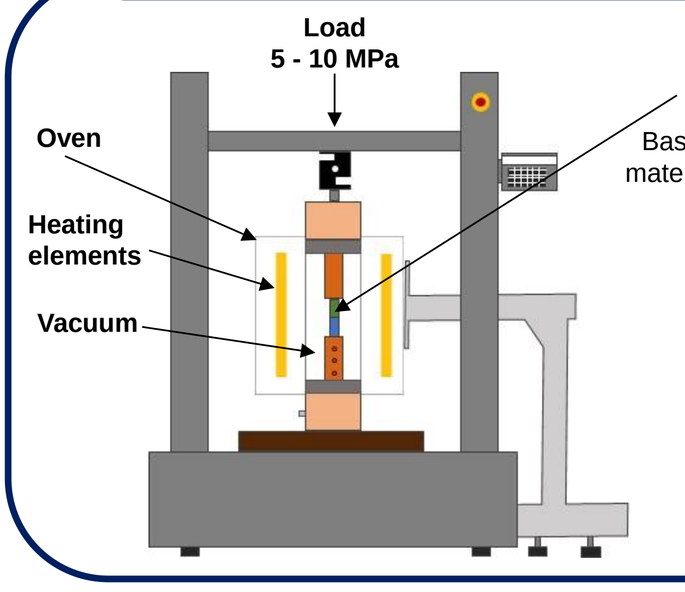
DC Magnetron Sputtering

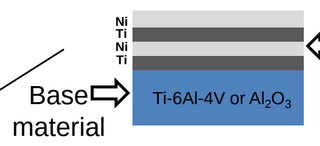




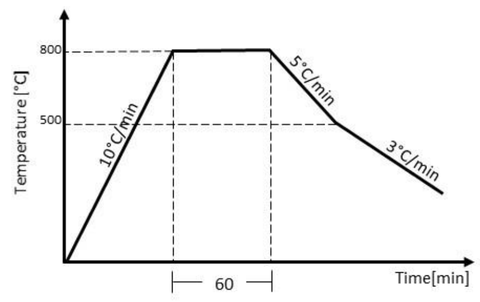
Ni/Ti reactive multilayer thin film
$\Lambda \approx 50$nm

Diffusion Bonding Process





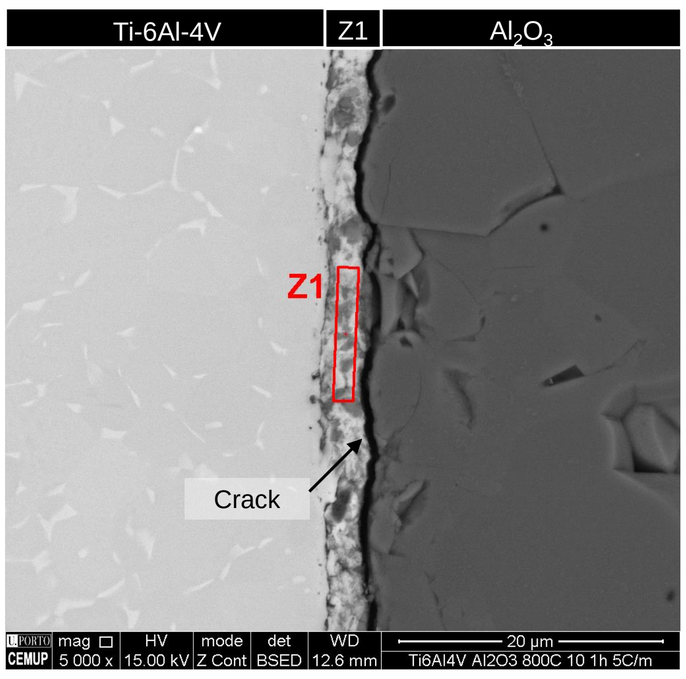
Multilayer thin film
Period (Λ) ≈ 50 nm
Total thickness ≈ 2.9 µm

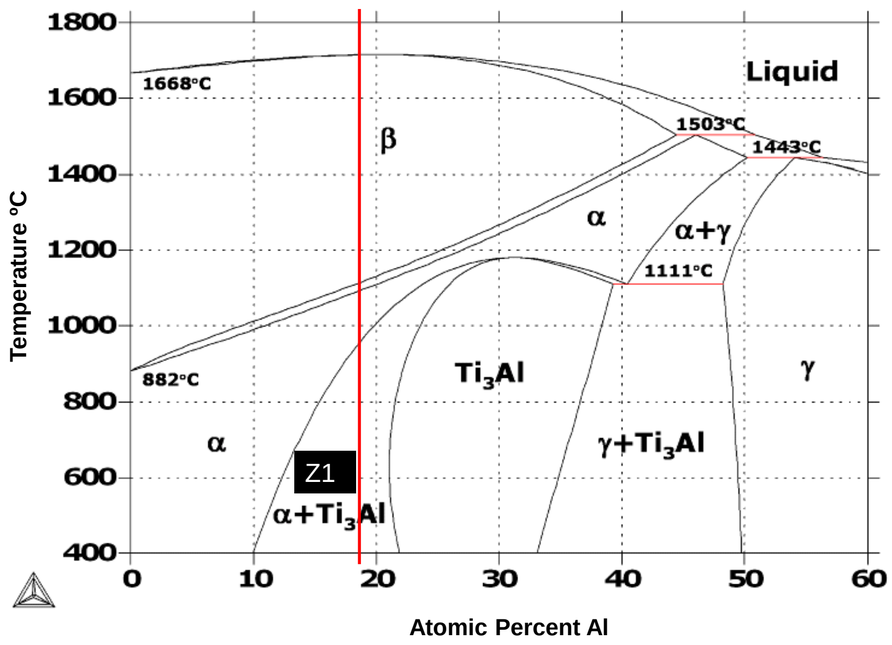


Temperature cycle

Results and Discussion

Without multilayers

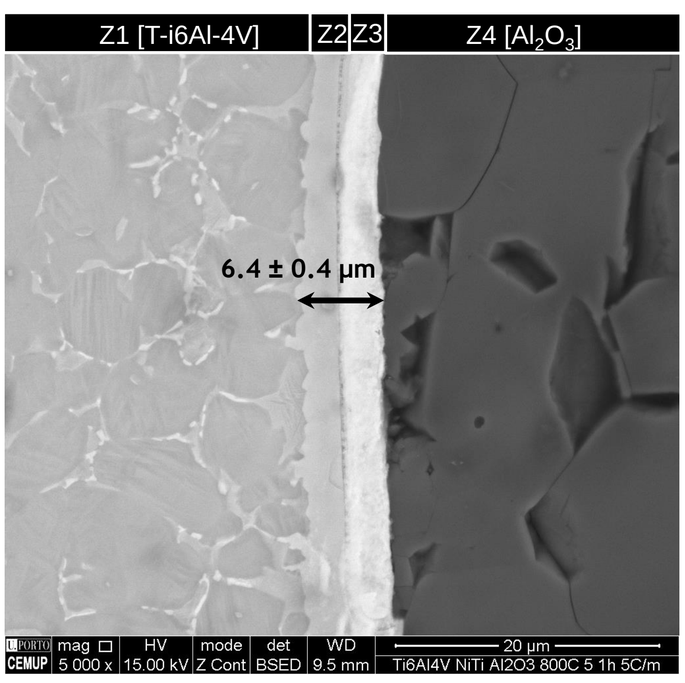


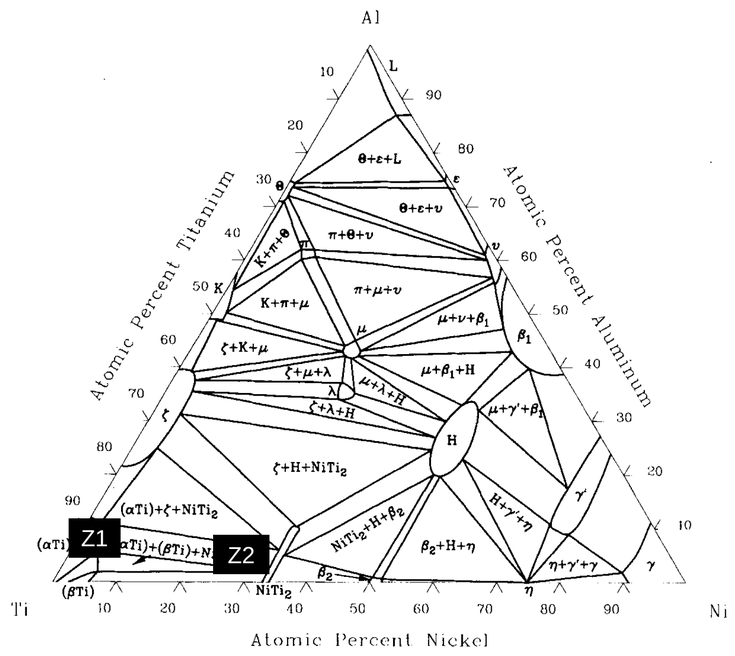


Al-Ti binary phase diagram

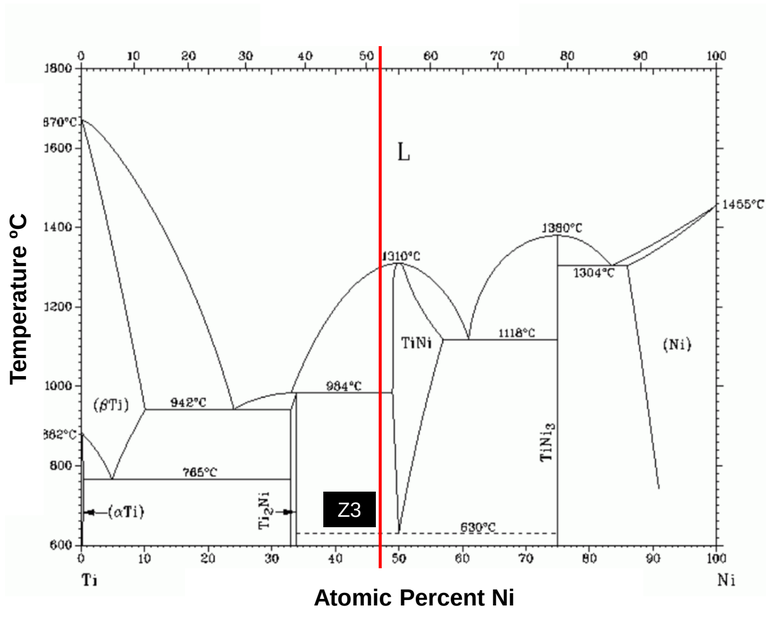
- Diffusion bonding was carried out at 800° C, 60 min and 5 MPa, without multilayers
- Cracks can be observed throughout the interface
- Possible phases at the interface : α-Ti and Ti_3Al

Ni/Ti multilayers





Al-Ni-Ti phase ternary diagram
800°C isothermal



Ni-Ti binary phase diagram

- Ti-6Al-4V was diffusion bonded to Al_2O_3 at 800° C, 60 min and 5 MPa, using Ni/Ti multilayer thin films
- Interface without pores or cracks
- Possible phases composing the interface: Z1 - Ti (α) + Ti (ß), Z2 - $NiTi_2$, Z3 - NiTi

Conclusions

The main goal of this study is to obtain sound joints between Ti-6Al-4V and Al_2O_3 using the diffusion bonding process assisted by reactive multilayer thin films. The use of Ni/Ti multilayers with 50 nm period improves the quality of the joint interface. However, brittle intermetallic compounds are formed at the interface region.

ACKNOWLEDGEMENTS

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